NETWORK SWITCHING UNIT FOR A COMMUNICATION SYSTEM

As a result of an increasing flexibility of the working conditions in terms of time and space, the number of those employees who do not perform their professional duties at their work station in the company is constantly increasing. It is known from "Das virtuelle Büro, telcomreport, No. 4, 1997, Siemens AG Berlin and Munich, that, on the one hand, an access to the local data resources of the company (also called 'remote LAN' in the literature) and, on the other hand, an access onto the communication performance features offered in the local communication network of the company (also called 'remote PBX' in the literature) regardless of the location of the employee are needed for an efficient handling of the tasks outside the company. Included among the performance features in addition to the standard performance features in, for example, an ISDN-oriented communication network are, for example, setting up a conference circuit or signalling when a message is received.

International Published Application WO 97/18662 discloses, for example, an arrangement wherein an external subscriber is connected via a public communication network to a "virtual presence server" allocated to a company. This "virtual presence server" controls the access of the external subscriber -- for the purpose of teleworking -- both to a communication system as well as to a local network of the company.

In current communication systems, for example, connection possibilities to a communication network brought to the communication system are realized by primary multiplex access units arranged therein that are also referred to as S_{2M} accesses. The communication network can, for example, be realized by an ISDN-oriented communication network (Integrated Service Digital Network). For access to a local data network, for example an Ethernet-LAN (Local Area Network) connecting a plurality of personal computers, via the ISDN-oriented communication network, a connection between the ISDN-oriented communication network and the local data network is realized via an external network switching unit -- often referred to as 'router' in the literature -- connected to a further S_{2M} access. To that end, the 'router' is equipped both with an S_{2M} interface as well as with a standard LAN interface,

whereby the S_{2M} interface is connected to the output of the S_{2M} access unit of the communication system and the LAN interface of the 'router' is connected to the local data network.

In view of its critical function, a 'router' realizes the layer 3 (switching layer) of the OSI reference model (Open Systems Interconnection), whereby networks with respectively different topology of the layers 1 (bit transmission layer) and 2 (protection layer) are physically connected with the assistance of a 'router' -- for example, Ethernet-LAN and ISDN-oriented communication network. In order to route data packets between the networks connected to a 'router', the address particulars -- destination and source address -- contained in routing information of the data packets are interpreted and evaluated by a control means located in the 'router'. Subsequently, the data packets are converted protocol-suited for a transmission.

Such an apparatus is known, for example, from Blitz, A. et al., "Integrating LAN, H-Channels and ATM into PBX technology", Proceedings of the International Switching Symposium (ISS '97), Toronto, Canada, 21-26 September 1997, Vol. 2, pages 573-579, XP000704513, with which a connection of a narrowband -- for example, ISDN-oriented -- communication system to a broadband local network is realized for a bidirectional data communication.

In order to be able to make the performance features realized by the communication network and offered at internal subscriber terminals available at an external terminal device, for example a terminal device connected to the communication system via an ISDN-oriented communication network, in the same way as at an internal terminal device -- as intended in the framework of 'teleworking' –, German Patent Application bearing Serial Number P19808368.8 has already disclosed that terminal device-oriented signalling information as are usually transmitted between the communication system and internal terminal devices connected thereto in the course of a signalling protocol be communicated between the communication system and the external terminal device via a further payload data connection (for example, a second ISDN-oriented B-channel) established in addition to the payload data connection (for example, a first ISDN-oriented B-channel).

The external terminal device is connected via the further payload data connection to a computer (often referred to as 'teleworking server' in the literature) connected to the local data network that controls the transmission of the terminal device-oriented signalling information between the communication system and the external terminal device. A conversion of the data format of the payload data connection, for example the data format of an ISDN-oriented B-channel, onto the data format of the local data network thereby ensues in an external 'router'.

In general, an S_{2M} interface comprises, first, 30 payload data channels that are fashioned as ISDN-oriented B-channels with a transmission rate of 64 kbit/s and, second, a signalling channel that is fashioned as ISDN-oriented D-channel with a transmission rate of 64 kbit/s. This means that the S_{2M} interface for the connection of the external 'router' is only optimally utilized given larger local data networks. Given smaller local data networks, the payload data channels of the S_{2M} interface are

A further advantage of the inventive network switching unit is comprised therein that, due to the implementation of the system components needed for a router function and those needed for a 'teleworking' function on a common assembly, only one payload data connection (instead of two payload data connections) for communicating payload data and terminal device-oriented signalling information between the external terminal device and the network switching unit need be set up for offering the performance features realized by the communication system at an external terminal device via a communication network.

Advantageous developments of the invention are indicated in the subclaims.

Due to the arrangement of a DTMF recognition unit and of an output unit for stored voice messages or, respectively, text messages on the network switching unit, the performance features realized by the comm system can also be offered at arbitrary external terminal devices -- and not only a terminal devices configured for 'teleworking'.

An exemplary embodiment of the invention is explained in greater detail below on the basis of the drawing.

Thereby shown are:

Figure 1 a structural image for the schematic illustration of a communication system with a network switching unit arranged therein;

Figure 2 a structural image for the schematic illustration of the critical function units of the network switching unit;

Figure 3 a structural image for the schematic illustration of two communication systems according to Figure 1 arranged in a communication network.

Figure 1 shows a schematic illustration of a communication system PBX with a network switching unit IGATE arranged therein and configured as subscriber line unit. The communication system PBX comprises further subscriber or, respectively, line units - a first and second line unit ABG1, ABG2 are shown by way of example - for connection of communication terminal devices or, respectively, for a connection to further communication systems arranged in a communication network KO. Further, the communication system PBX contains a switching network module

KN comprising a plurality of bidirectional, time-division multiplex-oriented switching terminals KA1,...KAk, whereby the time-division multiplex-oriented switching terminals KA1,...,KAk are configured as PCM terminals (pulse code mode modulation) - also referred to as PCM highways, speech highways or S_{2M} connections. Each PCM highway comprises, first, thirty payload channels that are fashioned as ISDN-oriented B-channels (integrated services digital network) with a transmission rate of 64 kbits/s and, second, comprises a signaling channel that is fashioned as ISDN-oriented D-channel with a transmission rate of 64 kbit/s. Via the switching terminal KAk, the switching network module KN is connected to a bidirectional, time-division multiplex-oriented PCM interface PCMS of the network switching unit IGATE. Via the further PCM terminals KA1, KA2, the switching network module KN is respectively connected to a bidirectional, time-division multiplex-oriented terminal SK of the first and of the second line unit ABG1, ABG2.

Further, a control unit STE comprising a plurality of control terminals SA1,..SAk is arranged in the communication system PBX. The control unit STE is connected to a control input SM of the switching network module KN via a control terminal SAk. Via the further control terminals SA1,...SA3, the control unit STE is connected, first, to an HDLC interface HDLCS arranged at the network switching unit IGATE and, second, is connected to control terminals SM of the first and of the second line unit ABG1, ABG2.

A communication network KO - for example, an ISDN-oriented communication network - composed of a plurality of communication systems connected to one another is connected to a network terminal NA - for example, a bidirectional, time-division multiplex-oriented S_{2M} terminal - of the first line unit ABG1. A first external terminal device KE1 having a data processing means DV that, for example, is fashioned as personal computer or as insert card for an existing terminal device, and a second external terminal device KE2 are connected to the communication network KO. A first internal terminal device KE3 having the communication system-internal telephone number 6833 is connected to a first subscriber terminal T1 - for example, to an S_0 terminal (2B + D, i.e. 2 ISDN-oriented payload channels and one ISDN-oriented signaling channel) of the second line unit

ABG2, and a second internal terminal device KE4 having a communication system-internal telephone number 4711 is connected to a second subscriber terminal T2.

A local network LAN, for example, an Ethernet-LAN (local area network) - is connected via an LAN interface LANS to the network switching unit IGATE. A plurality of computers D-S, TW-R, for example "personal computers" or "multi-media workstations", are connected to one another by the local network LAN.

Figure 2 shows a schematic illustration of the critical function units of the network switching unit IGATE. The network switching unit IGATE comprises an LAN access unit LAN-AE with an LAN interface, whereby the LAN interface LANS can be connected to the local network LAN. The network switching unit IGATE further comprises a PCM line unit PCM-AE having a bidirectional, time-division multiplex-oriented PCM interface PCMS, whereby the PCM interface PCMS can be connected to the switching terminal KAk of the switching network module KN of the communication system PBX. Further, the PCM line unit PCM-AE comprises an assembly switching network module BG-KN connected to the PCM interface PCMS. A DTMF recognition unit DTMF and an output unit S-AE are also arranged in the PCM line unit PCM-AE. The DTMF recognition unit DTMF serves the purpose of recognizing and evaluating control information in the form of DTMF signals received via a payload data connection conducted via the PCM interface PCMS. The output unit S-AE served for communicating stored voice messages to an external terminal device KE2 via a payload data connection.

Further, a signaling unit SE having an HDLC interface HDLCS is arranged at the network switching unit IGATE. Via the HDLC interface HDLCS, the signaling unit SE is connectible to the control terminal SAE of the control unit STE of the communication system PBX. The LAN line unit LAN-AE, the PCM line unit PCM-AE and the signaling unit SE are respectively connected via a terminal UA to a terminal EL, EP, ES of a conversion unit MH arranged at the network switching unit IGATE.

The conversion unit MH comprises a control unit SU. With the assistance of the control unit SU, data communicated to the network switching unit IGATE or, respectively, to the LAN line unit LAN-AE or the PCM line unit PCM-AE or the

signaling unit SE are communicated between the local network LAN and the payload data channels of the communication network KO brought to the network switching unit IGATE.

To this end, the control unit SU of the conversion unit MH comprises an evaluation unit BW-R for evaluating routing information - i.e. destination and source data - contained in data to be communicated and also comprises a switching unit VM-R for communicating the data from and to the local network LAN or, respectively, from and to the communication network KO dependent on the evaluation result. Further, signaling information are converted protocol-suited by a conversion unit KV-R of the control unit SU. To that end and given data to be communicated to the local network LAN, the signaling information incoming at the signaling unit SE are converted into corresponding routing information, and the payload data incoming at the PCM line unit PCM-AE together with the routing information that have been formed are converted into format-suited data, i.e. data adapted to the LAN format, and are communicated to the LAN line unit LAN-AE.

For an exchange of data between the local network LAN connected to the network switching unit IGATE and the communication network KO, the LAN line unit LAN-AE or, respectively, the LAN interface LANS has an unambiguous identification or, respectively, address allocated to it, i.e. an identification or, respectively, address that is valid worldwide. Since the applications that realize the data exchange - for example, a software module realizing data exchange - are resident on different levels of the OSI reference model, a plurality of identifications or, respectively, addresses valid on different levels of the OSI reference model are allocated to the LAN line unit LAN-AE. Thus, an unambiguous, assembly-specific LAN identification mac is allocated to the LAN line unit LAN-AE. The assembly-specific LAN identification mac realizes a hardware address of the LAN interface LANS resident on layer 1 of the OSI reference model and is stored in a non-volatile memory PROM arranged at the network switching unit IGATE.

Additionally, an unambiguous, logical network identification or, respectively, network address ipag is allocated to the LAN line unit LAN-AE. This is four bytes long and represents an address of the layer 3 of the OSI reference model -

for example, an Internet protocol address. The logical network identification ipag identifies both the LAN line unit LAN-AE as well as the local network LAN connected to the LAN line unit LAN-AE. The logical network identification ipag is stored in a memory area SP1 of a volatile memory SPF arranged at the network switching unit IGATE.

The network switching unit IGATE additionally comprises a control unit STW that comprises a protocol unit PROT and a filter unit FWALL. The control STW is connected via control terminals SW to the LAN line unit LAN-AE, to the PCM line unit PCM-AE, to the signaling unit SE of the conversion unit MH and to the memories PROM and SPF. The communication of data to be communicated between the local network ALN, the communication network KO and terminal devices KE3, KE4 internally connected to the communication system PBX is realized by the protocol unit PROT. Realized in the protocol unit PROT are, first, the Internet-specific protocols TCP/IP (transmission control protocol/Internet protocol), H. 323 as well as the PPP protocol (point-to-point protocol) designed for the transport of TCP/IP data packets and of H.323 data packets via a point-to-point connection, and the H.320 protocol conceived for a transmission of voice and data via an ISDN-oriented connection.

A security-oriented decoupling of the networks LAN, KN connected to the network switching unit IGATE is realized by the filter unit FWALL. As a result of the filter function realized in the filter unit FWALL, a data access from the local network LAN onto a potentially further communication system-internal local network is checked for authorization, as is a data access via the communication network KO to the local network LAN as well. For the realization of the filter functions, both the source as well as destination addresses contained in the routing information of the data to be communicated are checked for allowability (this check is often referred to as source and destination checking in the literature). When checking the source address and given a connection setup initiated via the communication network KO, the telephone number of the calling communication terminal device is checked on the basis of a list (not shown) with predetermined, authorized telephone numbers (is often referred to as subscriber authentification in the literature) and, thus, inadmissible

connections via the communication network KO are prevented. Further, the logical network identification ipag of data packets incoming at the LAN line unit LAN-AE are checked. When the source address is authorized for the exchange of data via the network switching unit IGATE, the destination address contained in the routing information is checked according to said criteria. Additionally, an authentification check of the source address can be implemented on the basis of the protocols PAP (password authentification protocol) and CHAP (challenge handshake authentification protocol) provided in the framework of the PPP protocol.

After the data have successfully run through the filter functions, i.e. after confirming the authorization of the data exchange between the communication terminal devices identified by the source and destination address, the destination address or, respectively, logical network identification ipag contained in the data are evaluated by the routing functions realized on the network switching unit IGATE or, respectively, at the conversion unit MH and the protocol unit PROT. When the local network LAN is identified by the logical network identification ipag, the data are correspondingly switched in said way via the conversion unit UE.

The volatile memory SPF also comprises a third memory area SP3 for storing logical destination network identifications ipe1,...ipek of further communication systems arranged in the communication network or, respectively, of the local network connected thereto that are provided for a data exchange with the local network LAN or, respectively, with the communication terminal devices connected to the local network LAN. To this end, a communication network identification rn1,...rnk respectively representing a telephone number of corresponding network switching units arranged in the further communication systems are stored in a fourth memory area SP4 of the volatile memory SPF allocated to the third memory area SP3. At least one communication network identification rn1,..rnk is allocated to every logical destination network identification ipe1,...,ipek stored in the third memory area SP3. Given data to be communicated to a communication system arranged in the communication network KO, the further conversion unit KVK-R arranged in the control unit STW of the network switching unit IGATE determines the corresponding logical destination network identification

ipe1,...,ipek stored in the third memory area SP3, and a corresponding payload data connection is setup via the communication network KO on the basis of the allocated communication network identification in1,...,ink stored in the fourth memory area SP4.

So that further communication systems arranged in the communication network KO can set up a corresponding payload connection to the communication system PBX or, respectively, to the network switching unit IGATE, an unambiguous communication network identification rnw is allocated to the network switching unit IGATE, this being stored in a second memory SP2 of the volatile memory SPF.

The exchange of data between local networks LAN1, LAN2 connected to a network switching unit IGATE1, IGATE2 and between a local network LAN1 and an external terminal device KE11 connected to a communication network KO shall be explained in greater detail on the basis of the structogram shown in Figure 3. The structogram schematically shows two communication systems PBX1, PBX2 arranged in a communication network KO and configured according to Figure 1. The two communication systems PBX1, PBX2 are connected via a PCM line unit PCM-AE1, PCM-AE2 to the communication network KO. Both communication systems PBX1, PBX2 comprise a network switching unit IGATE1, IGATE2 according to Figure 2.

The network switching unit IGATE1 arranged in the first communication system PBX1 comprises a first LAN line unit LAN-AE having an LAN interface (not shown). The first LAN line unit LAN-AE1 has a logical network identifier ipag1 = 139.1.20.0 allocated to it that is four bytes long. The network switching unit IGATE2 arranged in the second communication system PBX2 comprises a second LAN line unit LAN-AE2 having an LAN interface (not shown). The second LAN line unit LAN-AE2 has a logical network identification ipag2 = 140.7.27.0 allocated to it. Below, only logical network identifications ipag or, respectively, the Internet protocol addresses allocated to the individual units or local networks shall be considered, i.e. the transport realized in the layers 3 and 4 of the OSI reference model or, respectively, the exchange of data packets controlled by the TCP/IP protocols arranged therein shall be explained in greater detail.

A first local network LAN1 is connected to the first LAN line unit LAN-AE1, a communication terminal device KE10 being connected via said first local network LAN1 to the network switching unit IGATE1 or, respectively, to the first communication system PBX1. The logical network identification, i.e. the standardized Internet protocol address, is structured according to version 4, i.e. it comprises four bytes. The local network can thereby be unambiguously identified by the addressing information covering the first three bytes; the communication terminal KE10 in the local network can be identified by the addressing information covering the last byte. Due to the allocation of the Internet protocol address ipage1 = 139.1.20.0 to the first LAN line unit LAN-AE1, both the first LAN line unit LAN-AE1 as well as the first local network LAN1 connected thereto are identified by the first three bytes ipag = 139.1.20. Correspondingly, the communication terminal device KE10 connected to the first local network LAN1 exhibits the Internet protocol address ipag = 139.1.20.1.

A second logical network LAN2 is connected to the second LAN line unit LAN-AE2, a communication terminal device KE12 being connected via said second local network LAN2 to the network switching unit IGATE2 or, respectively, to the second communication system PBX2. The second local network LAN2 connected to the second LAN line unit LAN-AE2 has the Internet protocol address ipag = 140.7.27 allocated to it. The communication terminal device KE12 connected to the second local network LAN2 correspondingly comprises the Internet protocol address ipag = 140.7.27.1. Further, an external communication terminal device KE11 that exhibits the Internet protocol address ipag = 172.16.0.8 is connected to the communication network KO.

Given data - indicated by a dotted line V1 - to be communicated from the communication terminal device KE10 connected to the first communication system PBX1 to the communication terminal device KE12 connected to the second communication system PBX2, these exhibit the Internet protocol address ipag = 139.1.20.1 as source address and the Internet protocol address ipag = 140.7.27.1 as destination address. On the basis of the destination address and with the assistance of the evaluation and switching units KNK-R, VM-R arranged at the network switching

unit IGATE1, the telephone number of the network switching unit IGATE2 arranged in the second communication system PBX2 is identified and a corresponding payload data connection is setup to the network switching unit IGATE2 addressed on the basis of the telephone number. According to the destination address ipag = 140.7.27.1, the evaluation and switching units BW-R, VM-R arranged at the network switching unit IGATE2 communicate the communicated data packets to the second local network LAN2 or, respectively, to the communication terminal device KE12.

Given data - indicated by a broken line V2 - to be communicated from the external communication terminal device KE11 connected to the communication network KO to the communication terminal device KE10 connected to the first communication system PBX1, a payload data connection between the external communication terminal device KE11 and the network switching unit IGATE1 arranged in the first communication system PBX1 is setup in a first step on the basis of the telephone number of the network switching unit IGATE1 in the first communication system PBX1. The communicated data have the Internet protocol address ipag = 172.16.0.8 as source address and the Internet protocol address ipag = 139.1.20.1 as destination address. The communicated data packets are communicated according to the destination address ipag = 139.1.20.1 to the first local network LAN1 or, respectively, to the communication terminal device KE10 by the evaluation and switching units BW-R, VM-R arranged at the network switching unit IGATE1.

The collaboration of the critical system components needed for a "teleworking" shall be explained in greater detail below on the basis of Figures 1 and 2.

For offering performance features realized by the communication system PBX and available at internal subscriber terminals T1, T2 at an external communication terminal device connected to the communication network KO and configured for a "teleworking", terminal device-oriented signaling information that are based on a signaling protocol Cornet-TS as usually available in the signaling exchange between internal terminal devices KE3, KE4 and the communication system PBX are communicated between the external communication terminal device and the communication system PBX. The communication of the terminal device-oriented

simultaneously redirected to the fictitious terminal port FP of the network switching u nit IGATE.

Additionally, all terminal device-oriented signaling information (assuming the log-on of the first external terminal device KE1 at the communication system PBX with the internal communication system telephone number of the second internal terminal device KE4) to be communicated from the control unit STE of the communication system PBX to the second internal terminal device KE4 (internal communication system telephone number 4711) are redirected to the fictitious terminal port FP (with the internal communication system telephone number 3200) of the network switching unit IGATE. The terminal device-oriented signaling information are communicated from the control unit STE of the communication system PBX to the network switching unit IGATE, which communicates them to the first external terminal device KE1 in the way described above.

By communicating terminal device-oriented signaling information based on the signaling protocol Cornet-TS to the first external terminal device KE1, all performance features realized by the communication system PBX are made available to the first external terminal device KE1 in the same way they are made available to the second internal terminal device KE4. A communication of terminal device-oriented signaling information from the first external terminal device KE1 - assuming the log-on thereof at the communication system PBX - to the control unit STE of the communication system PBX ensues in the same way in the opposite direction.

Given a connection setup - which, for example, ensues by lifting up the receiver at the first external terminal device KE1 - initiated by the first external terminal device KE1 - assuming the log-on thereof at the communication system PBX - to a further (internal or external) terminal device - for example, to the first internal terminal device KE3 -, a connection setup message is communicated via the payload data connection DV to the teleworking computer TW-R. The teleworking computer TW-R forwards a connection setup message for the fictitious terminal port FP of the network switching unit IGATE to the control unit STE of the communication system PBX. In response thereto and in a first step, the control unit STE of the communication system PBX sets up a sub-connection between the fictitious terminal

port FP of the network switching unit IGATE and the switching network module KN of the communication system PBX by occupying a free payload channel of the PCM highway that connects the network switching unit IGATE to the switching network module KN.

In a next step, the teleworking computer TW-R communicates a readiness message to the first external terminal device KE1 via the payload data connection DEV. In response thereto, the first external terminal device KE1 sends the telephone number allocated to the first external terminal device KE1 in the communication network KO to the teleworking computer TW-R in a reply message. In a further step, a further sub-connection to the first external terminal device KE1 is setup from a further fictitious terminal port RP of the network switching unit IGATE (often referred to as "remote port" in the literature). After the switching of the sub-connection to the further sub-connection in the assembly switching network module BG-KN of the network switching unit IGATE, a dial tone sounds at the first external terminal device KE1 (signaling the readiness to input dial information).

The dial information - for example, 6833 for the first internal terminal device KE3 - input in response thereto at the first external terminal device KE1 are communicated via the payload connection DV to the network switching unit IGATE and are forwarded from the latter to the control unit STE of the communication system PVX. Subsequently, a terminal device connection between the first internal terminal device KE3 and the first external terminal device KE1 is setup by the control unit STE of the communication system PBX.

Given a connection setup to the second internal terminal device KE4 proceeding from a further (external or internal) terminal device - assuming the log-on of the first external terminal device KE1 with the internal communication system telephone number of the second internal terminal device KE4 - , a sub-connection between the further terminal device and the fictitious terminal port FP of the network switching unit IGATE is setup by the communication system PBX on the basis of the activated call redirection for the second internal terminal device KE4. In a next step, the teleworking computer TW-R communicates a readiness message to the first external terminal device KE1 via the payload connection DV. The first external

terminal device KE1 subsequently sends the telephone number allocated to the first external terminal device KE1 in the communication network KO to the teleworking computer TW-R in a reply message. In a further step, a further sub-connection to the first external terminal device KE1 is setup proceeding from a further fictitious terminal port RP of the network switching unit IGATE. In a final step, the sub-connection and the further sub-connection are coupled in the assembly switching network module BG-KN of the network switching unit IGATE, as a result whereof the terminal device connection between the first external terminal device KE1 and the further terminal device arises.

A communication of the voice and of the terminal device-oriented signaling information between the network switching unit IGATE and the first external terminal device KE1 ensues with H.323 data packets on the basis of the PPP protocol. With the assistance of the H.323 protocol, the terminal device-oriented signaling information to be communicated and the voice are compressed and converted into data packets based on the TCP/IP protocol.

After the end of the terminal device connection existing between the first external terminal device KE1 and the further terminal device, the further fictitious terminal port RP of the network switching unit IGATE is released by the teleworking computer TW-R and is thus available for a new connection setup between an arbitrary terminal device logged on at the communication system PBX and a further terminal device. In contrast thereto, the fictitious terminal port FP of the network switching unit IGATE remains allocated to the first external terminal device KE1 and is only released after a log-off of the first external terminal device KE1 initiated by the subscriber. After the log-off and due to the deactivation of the call redirection at the communication system PBX, the terminal device-oriented signaling information to be communicated to the subscriber by the control unit STE of the communication system PBX are communicated to the terminal port of the internal terminal device allocated to the subscriber - for example, at the terminal port of the second internal terminal device KE 4 having the internal communication system telephone number 4711.

For offering performance features realized by the communication system PBX and available at internal subscriber terminals T1, T2 to an arbitrary external

communication terminal device connected to the communication network KO, control information in the form of DTMF signals (dual tone multi-frequency) are communicated from the external terminal device to the network switching unit IGATE via a voice connection. For the DTMF signals, a characteristic signal is allocated to each key of a terminal device, this being communicated via the voice connection when the key is actuated. The signal differs in frequency and signal duration from the data usually communicated via the voice connection, so that the signals can be identified and interpreted at the network switching unit IGATE.

The external terminal device can be connected to the communication system via an arbitrary communication network, for example an analog communication network, an ISDN-oriented communication network or a radio telephone network. The demands made of the external terminal device are merely comprised therein that the MFV dial method (multi-frequency dial method) for generating DTMF signals is supported by the external terminal device.

For a log-on of the second external terminal device KE2 at the communication system PBX, a subscriber inputs, for example, a "teleworking" telephone number at the second external terminal device KE2. In response thereto, a voice connection is setup between the second external terminal device KE2 and the network switching unit IGATE.

For an identification of the second external terminal device KE2 at the communication system PBX, the output unit S-AE arranged at the network switching unit IGATE communicates a first, recorded voice message to the second external terminal device KE2 that prompts the subscriber to input the telephone number allocated to the second external terminal device KE2 in the communication network KO - referred to below as manual identification. Additionally, a second recorded voice message is communicated from the output unit S-AE to the second external terminal device KE2 for an authentification of the subscriber, this prompting the subscriber to input a personal identification number PIN. These identification and authentification data communicated in the form of DTMF signals via the voice connection are interpreted by the DTMF recognition unit DTMF and are forwarded via the LAN line unit LAN-AE to the teleworking computer TW-R. The teleworking

computer TW-R enters the second external terminal device KE2 as being identified, for example with an entry of the second external terminal device KE2 in a list (not shown) insofar as this was not already carried out in an earlier identification.

As result of the identifier PIN communicated in the authentification data, that internal subscriber terminal port of the communication system PBX via which the subscriber would like to log on at the communication system PBX is identified on the basis of a list (not shown) stored in the teleworking computer TW-R. When the identifier PIN A is communicated during the framework of the authentification, for example, then a log on of the second external terminal device KE2 ensues for the second internal terminal device KE4. Additionally, the subscriber can be requested to communicate a personal password.

When the telephone number allocated to the second external terminal device KE2 in the communication network KO - for example, in the framework of an ISDN connection (in the framework of the performance feature "calling party number") - was automatically communicated from the second external terminal device KE2 to the network switching unit IGATE - also referred to below as automatic identification - , a check is carried out in the teleworking computer TW-R to see whether the second external terminal device KE2 has already been identified, i.e. whether an entry for the second external terminal device KE2 is already present in the list. When the second external terminal device KE 2 has not yet been identified, the output unit S-AE of the network switching unit IGATE communicates the second recorded voice message to the second external terminal device KE2, this prompting the subscriber to input the personal identifier PIN and/or the personal password.

Alternatively, the identifier PIN communicated by the subscriber can be allocated to a fictitious terminal port of the communication system PBX. Subscribers to whom no physically existing internal terminal device is allocated can thus also use the performance features of the communication system PBX at the external terminal device.

A check of the log-on of the second external terminal device KE2 occurs on the basis of a list (not shown) stored in the teleworking computer TW-R that contains the internal communication system telephone numbers or, respectively,

identifiers PIN authorized for the "teleworking". When the check has confirmed the log-on, a fictitious terminal port - for example, the fictitious terminal port FP having the communication system - internal telephone number 3200 - of the network switching unit IGATE is allocated to the second external terminal device KE2 by the teleworking computer TW-R. At the same time and due to the activation of the performance feature "call redirection" realized by the communication system PBX, all calls directed to the internal subscriber terminal port (for example, the second subscriber terminal T2 of the second line unit ABG2 with the internal communication system telephone number 4711) identified by the internal communication system telephone number of, respectively, by the identifier PIN are redirected to the fictitious terminal port FP of the network switching unit IGATE.

When, following the log-on, the voice connection is interrupted, for example by hanging up the receiver at the second external terminal device KE2 (this corresponds to the normal case), then a renewed identification (communication of the telephone number allocated to the second external terminal device KE2 in the communication network KO) of the second external terminal device KE2 at the communication system PBX is necessary in order to setup a new voice connection to the network switching unit IGATE. Additionally, the authentification data must be re-transmitted in the framework of the manual identification.

Assuming the log-on of the second external terminal device KE2 at the communication system PBX with the internal communication system telephone number or, respectively, identifier of the second internal terminal device KE4, the control unit STE of the communication system PBX additionally redirects terminal device-oriented signaling information to be communicated to the second internal terminal KE4 to the fictitious terminal port FP of the network switching unit IGATE. In the above-described way, the control unit STE of the communication system PBX communicates the terminal device-oriented signaling information to the teleworking computer TW-R via network switching unit IGATE.

In the teleworking computer TW-R, a message (for example, a terminal device-oriented signaling information) communicated from the control unit STE of the communication system PBX to the fictitious terminal port FP is evaluated, and, in

instances wherein this message is to be forwarded to the second external terminal device KE2, is converted into a voice message corresponding to the terminal device-oriented signaling information. The voice message is subsequently communicated via a newly established voice connection to the second external terminal device KE2 and is output thereat, for example via a loudspeaker. Further, there is the possibility of communicating messages corresponding to the terminal device-oriented signaling information to SMS-compatible terminal devices (short message service), particularly radio terminal devices. To this end, a message is communicated to the appertaining "network provider", who communicates the corresponding text message to the terminal device at which the text message is output, for example at a display.

When, proceeding from a further (external or internal) terminal device, a connection setup to the second internal terminal device KE4 is initiated - assuming the log-on of the second external terminal device KE2 at the communication system PBX with the internal communication system telephone number or, respectively, identifier of the second internal terminal device KE4 -, a sub-connection between the further terminal device and the fictitious terminal port FP of the network switching unit IGATE is setup due to the activated call redirection. In a further step, a further sub-connection between a further fictitious terminal port RP of the network switching unit IGATE and the second external terminal device KE2 is setup on the basis of the telephone number of the second external terminal device KE2 in the communication network KO communicated in the identification data. In a final step, the sub-connection and the further sub-connection are coupled in the assembly switching network module BG-KN of the network switching unit IGATE, as a result whereof a terminal device connection between the second external terminal device KE2 and the further terminal device arises.

Given a connection setup initiated by the second external terminal device KE2 to a further (internal or external) terminal device, a voice connection to the further fictitious terminal port RP of the network switching unit IGATE is setup on the basis of a renewed input of the "teleworking" telephone number. After a communication of the identification data via the voice connection, the output unit S-AE of the network switching unit IGATE communicates a recorded voice message to

the second external terminal device KE2 that informs the subscriber about possible user actions such as, for example, output of a voice message stored in the communication system PBX or setup of a terminal device connection proceeding from the second external terminal device KE2 to a further terminal device. Due to the input of a significant key combination at the second external terminal device KE2, a control information corresponding to the key combination is communicated in the form of DTMF signals via the voice connection to the network switching unit IGATE that signals the communication system PBX that, proceeding from the fictitious terminal port FP of the network switching unit IGATE, a terminal device connection is to be setup to a further terminal device. Subsequently, the control unit STE of the communication system PBX sets up a sub-connection between the fictitious terminal port FP of the network switching unit IGATE and the switching network module KN of the communication system PBX by occupying a free payload channel of the PCM highway connecting the switching network module KN and the network switching unit IGATE.

After a coupling of the voice connection with the sub-connection in the assembly switching network module BG-KN of the network switching unit IGATE, the dial tone sounds at the second external terminal device KE2. The dial information subsequently input at the second external terminal device KE2 - for example 6833 for the first internal terminal device KE3 - are communicated to the network switching unit IGATE in the form of DTMF signals via the voice connection and this network switching unit IGATE forwards these to the control unit STE of the communication system PBX. Subsequently, the control unit STE of the communication system PBX sets up a terminal device connection between the second external terminal device KE2 and the first internal terminal KE3.

When there is the possibility at the second external terminal device KE2 of communicating the telephone number allocated to the second external terminal device KE2 in the communication network KO automatically to the network switching unit IGATE, for example in the framework of an ISDN connection (in the framework of the performance feature "calling party number"), then the subscriber can initialize a connection setup proceeding from the communication system PBX by inputting a

specific "teleworking" telephone number. The network switching unit IGATE recognizes on the basis of the specific "teleworking" telephone number that a terminal device connection to a further terminal device is to be setup from the second external terminal device KE2 and does not accept the call of the second external terminal device KE2. In a next step and proceeding from the communication system PBX, a connection proceeding from the further fictitious terminal port RP of the network switching unit IGATE is set up to the second external terminal device KE2 on the basis of the telephone number of the second external terminal device KE2 in the communication network KO automatically communicated in the framework of the ISDN connection, so that no charges for the terminal device connection to the further terminal device to be setup are incurred by the subscriber at the second external terminal device KE2.

The control information sent from the second external terminal device KE2 during a terminal device connection existing between the second external terminal device KE2 and a further terminal device are communicated to the network switching unit IGATE in the form of DTMF signals via the terminal device connection. The control information are identified at the network switching unit IGATE by the DTMF recognition unit DTMF and are forwarded to the teleworking computer TW-R. In the teleworking computer DW-R, the received control data are converted into terminal device-oriented signaling information, for example on the basis of a list (not shown). These converted terminal device-oriented signaling information are forwarded via the network switching unit IGATE to the control unit STE of the communication system PBX. If the control information communicated by the second external terminal device KE2 in the form of DTMF signals cannot be interpreted by the network switching unit IGATE, then the DTMF signals are forwarded to the further terminal device.

After the end of the terminal device connection existing between the second external terminal device KE2 and the further terminal device, the further fictitious terminal port RP of the network switching unit IGATE is released by the teleworking computer TW-R and is thus available for a new connection setup between an arbitrary terminal device logged on at the communication system PBX and a